ORIGINAL ARTICLE

The Role of Multislice Computed Tomography (MSCT) in the Detection of Blunt Traumatic Intra Abdominal Injury: Our Experience in Hospital Tengku Ampuan Afzan (HTAA), Kuantan, Pahang

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SUMMARY
Multislice computed tomography (MSCT) is the imaging modality of choice in assessing clinically stable patients with blunt abdominal trauma. This study assessed the role of MSCT in the detection of intra abdominal injury caused by blunt trauma in our centre within a two-year-period (2008-2009). A total of 151 patients had MSCT abdomen for blunt abdominal trauma within this study period. Positive scan were seen in 126 patients (83.4%). Out of these positive scans, liver, spleen and renal injuries were seen in 42.1% (n=53), 34.9% (n=44) and 30.0% (n=34) of cases respectively. Laparotomies were performed in 45 patients. Out of these 45 laparotomies, 10 patients had surgically significant injuries that were missed on CT scan findings. The injuries were bowel perforation (n=4), serosal tear of bowel (n=1), mesenteric injuries with active haemorrhage (n=3), spleen injury (n=1) and liver injury (n=1).

KEY WORDS:
Computed Tomography, Blunt Abdominal Trauma, Injuries

INTRODUCTION
Blunt abdominal injuries are often difficult to be accurately evaluated clinically. It can cause multiple injuries and these injuries may be masked by other more marked external injury. MSCT has been accepted as the diagnostic imaging of choice for the evaluation of blunt abdominal trauma in haemodynamically stable patients. Previous studies had shown its high sensitivity, specificity, and accuracy in the detection and extent of abdominal injuries.

The existence of clinically important injuries was verified either during laparotomy or with clinical notes during hospital stay. All patients that were managed conservatively were traced on follow up notes and outcome of patients at the end of follow-up. The imaging diagnosis was compared with the operative findings where applicable. Positive scan was defined as CT scan study that showed any solid organ injury, bowel and mesenteric injury or retroperitoneal injury. Presence of isolated free fluid in the peritoneum is not considered as positive scan. Free fluid quantification was done according to system given by Federle et al. and was graded as small, moderate or large. Individual organ injuries were graded according to American Association for the Surgery of Trauma (AAST) classification.

This study assessed MSCT detection of intra abdominal injury following blunt trauma and we presented our results in this report.

MATERIALS AND METHODS
The institutional review board approved this study. We retrospectively traced images and reports of all patients who underwent MSCT for suspected blunt traumatic intra-abdominal injuries in a two-year period at our institution. A total of 151 patients were collected from January 2008 until December 2009.

For all patients, the scans were performed using a four-row MSCT scanner; Somatom Siemens Volume Zoom (Siemens Medical Systems, Erlangen Germany) with slice width of 10mm, 2.5 mm collimation, 0.75s rotation time, table feed of 15 mm and 3 mm reconstruction interval. The CT performed from the dome of the diaphragm to the symphysis pubis. Pre- and post-contrast scans were routinely performed and patients received 2ml/kg of intravenous contrast medium (Iohexol 300 mg/ml). Oral contrast was not routinely administered in our patients. The contrasted CT scans were acquired during portal venous phase, approximately 80 seconds after contrast injection. Additional delayed images were performed when investigating genitourinary tract trauma. When necessary, sagittal and coronal images were reconstructed using multiplanar reconstruction (MPR) technique.
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RESULTS
From the 151 patients, 122 (80.8%) patients were male and 29 (19.2%) patients were female. Majority of the patients were Malays (74.2%). Age ranges from 2 to 84 years with mean age of 26.4 years. Motor vehicle accidents were the most common cause of trauma comprising of 82.8%, followed by home injury (6.6%) and industrial accidents (4.6%). The rest were sports injury and assault cases, 2.0% and 4.0% respectively. MSCT were performed within 24 hours of trauma in 86% and after 24 hours in 14% of cases.

Positive scans were detected in 83.4% (n=126) of cases and negative study in 16.6% (n=21). From the 126 patients with positive MSCT, 42 (33.3%) patients were operated. Two patients died (day 2 and day 3 post operation) due to multiple injuries sustained and the rest 40 patients recovered fully on subsequent follow up. The other 84 (66.7%) patients with positive MSCT were managed conservatively. Clinical notes of 9 patients in this group were incomplete and 79 others had uneventful complete recovery. In 21 patients with negative CT scan, 3 patients subsequently had laparotomy; two of which confirming the absence of significant injury and one patient had small bowel perforation that required surgical repair (false negative). The other 18 patients were managed conservatively. Two patient’s record were incomplete, the rest 16 patients showed no clinical features to suggest that traumatic injuries were missed on subsequent follow up (Figure 1).

Laparotomies were performed in 45 patients that confirmed the MSCT findings in 35 patients (77.8%). From these 35 cases, additional injuries were noted in 9 cases during the operation. However, these injuries were mild and didn’t require surgical intervention. The injuries were pancreatic contusions (n=4), bowel wall contusions (n=4) and mesenteric tear with no active bleeding (n=1). Ten of 45 patients who underwent laparotomies had undetected surgically significant injuries (Table I). All these patients had concomitant more than one organ injuries except one case with isolated massive haemoperitoneum (false negative). A coincidence of positive CT findings and negative laparotomies has not been observed; therefore no false positive CT was detected. Statistical analysis showed significant correlation between grades of injury and type of management. Those with high grade organ injuries were more likely to have operation compared to those with low grade organ injuries (Table II).

Visceral injuries
Out of 126 cases of positive scans, 92 cases demonstrated one-organ injury, 23 cases with two-organ injuries, 3 patients with three-organ injuries, 1 patients with more than three organ injuries and 7 patients had retroperitoneal soft tissue injury without associated organ injuries. The commonest visceral injuries were liver, spleen and renal which comprised of 42.1% (n=53), 34.9% (n=44) and 30.0% (n=34) of cases in relation to positive scans respectively. The frequency of visceral injuries and the grading distribution of the injuries were illustrated in Table III, Table IV, Table V and Table VI.

From 53 patients with liver injury, 35 cases (66.0%) demonstrate liver injury alone and the rest were associated with kidney injury (n=6), spleen injury (n=5), adrenal (n=1) and multiple organ injuries (n=6). Liver injuries were managed conservatively in 77.4% (n=41) and operatively in 22.6% (n=12). One liver injury was missed on MSCT as proven by laparotomy.

From 44 patients with spleen injury, 29 cases (65.9%) demonstrate spleen injury alone and the rest were associated with kidney injury (n=7), liver injury (n=5), pancreas (n=1) and multiple organ injuries (n=2). Spleen injuries were managed conservatively in 50% of the patient and operatively in the remaining 50%. One spleen injury was missed on MSCT as proven by laparotomy.

From 34 patients with renal injury, 16 cases (47.1%) demonstrated renal injury alone and the rest were associated with liver injury (n=6), spleen injury (n=7), pancreas (n=1) and multiple organ injuries (n=4). Renal injuries were managed conservatively in 67.6% (n=23) and operatively in 32.4% (n=11).

From 7 patients with urinary bladder injury, 4 cases were extraperitoneal and 3 cases were intraperitoneal injuries. Operations were done in all 3 cases of intraperitoneal urinary bladder injuries. All patients with extraperitoneal injuries were managed conservatively. Associated pelvic fractures were seen in 57.1% (n=4) of cases.

Pancreatic injuries detected with MSCT were seen in 5 cases. In 3 patients the MSCT was performed more than 24 hours after initial trauma. All these three patients had complete transections of the pancreas on MSCT and one of the cases was complicated by pseudocyst formation that required percutaneous drainage while the other 2 cases recovered fully after conservative management. In the 2 cases where MSCT were done on the same day of trauma, scan revealed pancreatic contusion in both cases. These two patients had laparotomies done for other organ injuries; one patient with bowel perforation and the other patient had multiple injuries involving the liver, spleen and kidneys. There were 4 cases of pancreatic contusions missed on CT scan review and noted during operation for other organ injuries.

Adrenal injuries were seen in 5 cases and in 3 cases it was associated with other intra abdominal organ injuries. In the other 2 cases the patients had adrenal injuries without other visceral injuries. However ribs fractures and lung contusions were seen in these 2 cases.

One case of urethral injuries diagnosed on MSCT had comminuted pelvic fractures. The balloon’s of Foley’s catheter was abnormally located making the diagnosis of urethral injuries straightforward and it was confirmed with ascending urethrogram performed later.

Bowel and mesenteric injuries
MSCT detected bowel injuries in 5 patients and in all these patients operation confirmed the CT findings. All these cases demonstrated free extraluminal air.

There were 8 cases of surgically significant undiagnosed bowel and mesenteric injuries found during laparotomy.
Seven of the cases demonstrated co-existence other organ injuries; urinary bladder injuries (n=2), liver injuries (n=2), spleen injuries (n=2) and kidney injury (n=1).

**Retroperitoneal soft tissue injuries**
Retroperitoneal soft tissue injuries were seen in 34 cases. In majority of the cases, the retroperitoneal injuries were associated with other injuries such as renal, adrenal, pancreas and liver injuries (n=27). In 7 cases, no other visceral injuries were present but patients had pelvis fracture.

**Haemoperitoneum**
Haemoperitoneum was seen in 66.2% (n=100) of the cases reviewed; minimal (n=44), moderate (n=31) and massive (n=25). There were 4 cases of haemoperitoneum with negative scan. One was the false negative case with laparotomy-proven bowel injury. The other 3 cases recovered uneventfully after conservative management without any blood transfusion or clinical features suggestive of missed intra abdominal injury.

There were 30 cases of positive MSCT with no haemoperitoneum. The organ injuries in these cases were liver (n=10), renal (n=8), spleen (n=3), liver and renal (n=1), extraperitoneal urinary bladder injury (n=1) and retroperitoneal injuries (n=7). Majority of these patients had Grade I or Grade II organ injuries. Only three patients from this group had Grade III renal injuries and two of them were operated. The rest had uneventful recovery after conservative management.

Contrast extravasation suggestive of active hemorrhages was seen in 6.3% (n=8) of the positive cases reviewed. Organ injuries associated with contrast extravasations were liver (n=5), spleen (n=2) and kidney (n=1). Seven cases with contrast extravasations identified on MSCT were operated. In all of these seven cases, active haemorrhage was confirmed intraoperatively. One patient with contrast extravasation and kidney injury detected on MSCT was managed conservatively. A repeat CT 3 weeks later showed functioning right kidney with residual perirenal haematoma [Figure 2(a) and (b)].

**DISCUSSION**
Abdominal injury from blunt trauma posed a challenge to clinicians in giving accurate diagnosis. Many of these patients were the victims of multiple injuries and the clinical signs and symptoms of the intra abdominal injury may be masked by more obvious or compelling injuries elsewhere. However, MSCT can provide a rapid, accurate appraisal of the status of the abdominal viscera, retroperitoneum and abdominal wall.

The use of MSCT has influenced the current trends in the management of blunt intraabdominal injuries towards non-operative management. Even though the decision for operative intervention was usually based on clinical criteria rather than on imaging findings, MSCT information frequently increases the diagnostic confidence of the surgeons and plays an important role in decreasing the rates of unnecessary exploratory laparotomy.
The Role of Multislice Computed Tomography (MSCT)

Total MSCT Cases
(n=151)

Positive
(n=126)

Operation
(n=42)

Fully recovered
(n=40)

Died
(n=2)

Conservative
(n=84)

Fully recovered
(n=79)

Incomplete record (n=9)

Negative
(n=25)

Operation
(n=3)

Conservative
(n=22)

Negative findings
(n=2)

Missed bowel injury (n=1)

Fully recovered
(n=20)

Incomplete record (n=2)

Fig. 1: Schematic diagram showing summary of the cases reviewed.

Fig. 2: Axial MSCT, post contrast in a 32-year old man whose motorcycle skidded. (a) MSCT on the day of accident showed contrast extravasations (arrows) with huge perirenal haematoma (H). (b) MSCT repeated 3 weeks later showed residual perirenal haematoma. RK=right kidney, LK=left kidney.
In 83.4% of our cases, MSCT were positive and revealed substantial abdominal injury, retroperitoneal haematoma or pelvis fractures. The positive MSCT in previous reported series widely ranged from 26% to 89% [4,14]. This can be due to different definition of positive scan by various authors. For example, some studies did not include pelvis fracture and haemoperitoneum as criteria for positive CT scan while others classified presence of minimal free fluid without definite organ injury as positive scan. An international consensus would be required in the future to improve the accuracy and consistency of reporting trauma cases. In our study, even though isolated haemoperitoneum without identifiable organ injuries is not classified as positive scan, the percentage of positive scan is still high. Good selection of patients by the surgeons is the possible explanation for the high positive scans.

Many previous studies reported spleen as the most common organs injured in blunt abdominal trauma [14-16]. Distribution of organ injuries in our study slightly differs with liver injuries being more common than spleen injuries. Liver as the only organ injury were seen in 35.1% of cases, however total liver injuries including those involving multiple organ injuries were as high as 40.8% of cases. This is higher than previous report that stated up to 25% of patients had liver injuries detected if whole-body CT scan is performed as initial diagnostic procedure in severely injured blunt trauma patients [17]. This is an important fact as liver injury is associated with significant morbidity and mortality despite advances in surgical treatment [17].

Our result showed that operations were more common in higher grade organ injuries. Conservative management was successful in 77.4% of liver injuries and 50% of splenic injuries. This is lower compared to other reported series with successful conservative management of solid organ injuries ranged from 80% to 95% of cases [9,18,19]. One of the possible reasons for this difference is due to unavailability of interventional radiologist in our centre to perform angiogram and embolization as part of non-operative management of organ injuries during the study period.

Pancreatic injuries were difficult to be diagnosed by imaging as illustrated in our cases. Total of 9 pancreatic injuries and only 5 cases were detected on MSCT while 4 cases were missed on CT review. Three of 5-pancreatic injuries detected on MSCT had the scan performed more than 24 hours after the trauma due to its nonspecific presentation and delayed clinical diagnosis. All three cases were pediatric patients injured by handlebar of bicycle and MSCT revealed transected pancreas. The difficulty in establishing a diagnosis of pancreatic injury has been stressed by various authors [20,21]. Clinical, laboratory and radiographic findings are highly variable and nonspecific [22,23]. One of the reasons was due to elastic nature of pancreatic tissue that can bounce back to its normal architecture after an injury [24]. In patients with clinically suspicious of pancreatic injury, repeat CT scan after few hours after an initial negative CT scan can be helpful [25,26]. CT scan has proved to be extremely helpful in identifying complications related to pancreatic injury including pseudocyst and abscess [25].

Free intra-peritoneal fluid was a common finding in our study as previously noted by other authors [14,27]. It is positive in 66.2% of our cases (n=100). There were 4 cases of haemoperitoneum with negative scan. One was moderate
haemoperitoneum that was the false negative case with laparotomy-proven bowel injury. The other 3 cases were minimal haemoperitoneum recovered uneventfully after conservative management without any blood transfusion or clinical features suggestive of missed intra abdominal injury. This findings supported statements from previous study that small amount of intraperitoneal fluid as the sole abnormality shown by CT can be treated conservatively but larger amount of fluids have a higher likelihood of being associated with bowel or mesenteric injury20.

In our patients, there were 24% of positive MSCT with no haemoperitoneum (n=30). This is higher compared to previous study which reported 11% of liver and 12% of spleen injuries had no free fluid visible on CT scan27. The importance of this fact is to the emergency and surgical team as these are the cases that can be missed based on diagnostic peritoneal lavage and focused abdominal sonography in trauma (FAST) assessment.

Contrast extravasation is an important finding on MSCT of blunt abdominal trauma3,11,12. It is suggestive of active haemorrhage and was reported in 6.5% to 43% of patients28-30. Contrast extravasation was seen in 6.3% (n=8) of the positive cases reviewed in this study. Out of these 8 cases, 7 cases had operation and active haemorrhage was documented. One patient was successfully managed conservatively (Figure 1). Even though contrast extravasation was previously reported as a strong predictor of unsuccessful nonoperative management, a recent study reported no association between contrast extravasation and the need for transfusion, mortality or splenectomy. Patients with contrast extravasation can still be treated without surgery based on the clinical condition11,12.

Bowel and/or mesenteric injuries were the commonest injury missed in our study. There were 8 cases of significant bowel and/or mesenteric injuries and 5 cases of non-significant bowel and/or mesenteric injuries, which were missed. Re-review of MSCT images revealed changes suggestive of bowel and mesenteric injuries in all cases except one false negative MSCT. Extraluminal air was missed in 2 of 8 significant bowel and/or mesenteric injuries. The findings were subtle. The sensitivities and specificities of MSCT in the detection of bowel injuries ranged from 64-95% and 48-84% respectively14,15. The reliance on presence of free air to diagnosed bowel perforation was the main reasons for the high percentage of missed bowel and mesenteric injuries in our series. The low sensitivity and high specificity of this sign is well-documented3. Review of the reports revealed that abnormality suggestive of these injuries was described in the findings however the diagnosis of bowel and/or mesenteric injuries was not given as a conclusion. The signs of bowel and mesenteric injuries are abnormal bowel enhancement, bowel wall defect, bowel dilatation, bowel wall thickening, abrupt termination of mesenteric vessel, vessel beading, extravasation of contrast from mesenteric vessels and focal mesenteric haematoma.

CONCLUSION
MSCT is a useful tool for the evaluation of blunt abdominal trauma especially in the detection of solid organ injuries and retroperitoneal haematoma. However assessment of bowel and mesenteric injury was not similarly effective in our study. Radiologists should diligently search for not only the characteristic free air sign which can be subtle but for other signs suggestive of bowel and mesenteric injury to increase interpretation accuracy and ability to detect significant bowel and mesenteric injuries based on CT examination. It is also important to note that absence of haemoperitoneum does not exclude intra abdominal injury but minimal haemoperitoneum as isolated findings may be safely managed conservatively. However, final decision should be based on clinical assessment rather than radiological findings.

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REFERENCES

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